Transcutaneous Electrical Nerve Stimulation for Low Back Pain

A Comparison of TENS and Massage for Pain and Range of Motion

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Patients with acute or chronic low back pain were treated in a double-blind study that compared transcutaneous electrical nerve stimulation at intense levels and gentle, mechanically administered massage. Transcutaneous electrical nerve stimulation produced significantly greater pain relief, based on two measures of the McGill Pain Questionnaire, and significant improvement in straight leg raising. There were no significant differences between the two groups in back-flexion scores. Pain-relief scores and range-of-motion scores were significantly correlated. The results indicate that pain-relief scores provide valuable information and can easily be obtained from patients for whom pain is a major symptom.

Key Words: *Electric stimulation, Movement, Pain.*

Transcutaneous electrical nerve stimulation (TENS) has been increasingly used in physical therapy for the relief of acute and chronic pain. Two procedures are commonly used: 1) prolonged stimulation at low intensities through an active electrode over the painful area,[1, 2] and 2) stimulation at higher but not painful intensities over the painful area for relatively brief periods, 20 to 30 minutes, for example.[1–5] The latter procedure is often described as "hyperstimulation analgesia," a designation for a variety of procedures in which intense and sometimes painful stimulation is used to relieve persistent pain.[6, 7]

Despite the widespread use of TENS, there have been few double-blind studies to assess the effectiveness of the procedure. Thorsteinsson and associates found that for the treatment of several pain syndromes TENS stimulation was significantly more effective than a placebo device when the electrodes were applied over the center of pain or over an unrelated nerve trunk.[8, 9] Transcutaneous electrical nerve stimulation was especially more effective than the placebo for patients with neuropathy when stimulation was applied over the related nerve trunk. These studies, however, do not meet all the criteria for a valid double-blind design. The patients were told that "the study was double-blind, consisting of treatment sessions with a genuine stimulator and with a placebo device that gave no electrical output into the electrodes. The expected sensation of stimulation was explained to each patient, and each was asked to record the effectiveness of the device in relieving pain. . . ."[8(p8)] It is difficult to believe that after these instructions the patients did not know whether they received real electrical stimulation or the placebo.

A better design for such a study is to investigate, under double-blind conditions, the relative effectiveness of two different procedures, each of which produces a sensory input and is potentially capable of producing pain relief. Our purpose was to carry out

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a study of this design to compare TENS and gentle massage when each is applied over the painful area.

METHODS

Subjects

The subjects were 41 patients (19 men and 22 women) who were referred to the Physiotherapy Department of the Montreal General Hospital for treatment of low back pain. The average age of the patients was 46.3 years, and the average duration of pain was 36.2 weeks. All of the patients were ambulatory and were judged to be sufficiently intelligent to understand the instructions of the experiment.

Equipment

The TENS stimulators used were standard equipment in the Physiotherapy Department: a Neuromod Model 3702* and a Neuroblock-6.† The active electrode was placed securely at the center of the painful area of the back, and the second electrode was placed on the lateral aspect of a thigh. The frequency of the output was set at 4 to 8 Hz, and the current intensity was raised until the patient reported that it was unpleasant. The intensity was then reduced to a level that the patient reported he could tolerate. Adjustments in the intensity were made during the session to maintain it at the same tolerable level.

The gentle massage used was produced by placing on the skin four suction cups which were kept in place by mild negative pressure within each cup. A specially constructed apparatus produced slowly varying changes in pressure so that a constant, gentle massage was applied to the skin.

Tests

The McGill Pain Questionnaire (MPQ), shown in the Figure, was used to measure pain.[10] It was administered before and after each treatment so that the percentage change in pain could be calculated. The two main indexes measured by the MPQ are 1) the pain rating index (PRI), which is the sum of the rank values of the words chosen from 20 sets of qualitative words, each set containing two to six words that describe the sensory, affective, and evaluative properties of pain, and 2) the present pain intensity (PPI), a measure of the overall pain intensity, which is scored from 1 to 5 (1 = mild, 2 = discomforting, 3 = distressing, 4 = horrible, 5 = excruciating). The percentage changes in the two indexes were calculated by comparing the scores obtained before and after treatment. The MPQ has been found to provide reliable and valid quantitative information about the subjective experience of pain.[13, 14]

In addition, each patient received two range-of-motion (ROM) tests[11]—straight leg raising (SLR) and back flexion—before and after treatment to obtain objective measures of change in motor capacity. The ROM tests were chosen because they did not require the test administrator to examine the area that was stimulated, and he would not be aware of signs indicating which treatment the patient received.

Procedure

One group (n = 20) received TENS stimulation, and the other group (n = 21) received massage. The treatments were given twice a week, for 30 minutes each, until one of the following occurred: 1) the 10 treatments were completed, 2) the patient considered the pain sufficiently relieved that he no longer needed or wanted therapy, 3) the patient stated that the pain had not been helped and requested another form of standard physical therapy, or 4) the therapist judged the patient's condition to be worse. All patients received the same standard exercises for low back pain at the conclusion of each stimulation treatment.

The treatments were carried out in a double-blind design. All the materials for recording data on pain and ROM were placed in an individual file for each prospective patient. Although the study was designed for a quota of 20 patients in each group, additional files were prepared in case an inadvertent loss of data during the study required replacement of data to meet the quota. Therefore, the retrieval of a file that was thought to be lost led to an n of 21 in the massage group. Each file also contained a sealed envelope with a card designating "TENS" or "Massage." The sealed envelope was placed with each file on the basis of a randomizing procedure[12] so that the patients were randomly assigned to each group.

The research coordinator examined daily the list of patients who were scheduled to receive physical therapy and chose those patients referred for treatment of low back pain who were suitable for the study. The patients received an informed consent form that described the two stimulation techniques and the design of the study. They were told that each technique could potentially relieve their pain with equal effectiveness. After the patients signed the forms, they were assigned their randomly ordered file for testing and for treatment. The patients were referred to the research associate who administered the MPQ and ROM tests and recorded the results in the file. The patients were then sent with the sealed envelope from that file to one of six physical therapists who had

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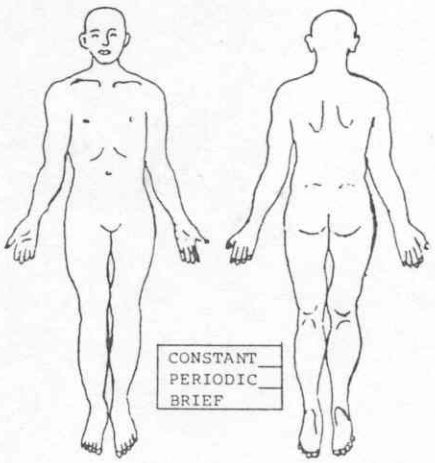
McGill - Melzack Pain Questionnaire

Patient's Name _____ Date _____ Time _____ am/pm
Analgesic(s) _____ Dosage _____ Time Given _____ am/pm
_____ Dosage _____ Time Given _____ am/pm

Analgesic Time Difference (hours): +4 +1 +2 +3
PRI: S_____ A_____ E_____ M(S)_____ M(AE)_____ M(T)_____ PRI(T)_____
(1-10) (11-15) (16) (17-19) (20) (17-20) (1-20)

1 FLICKERING	11 TIRING	
QUIVERING	EXHAUSTING	
PULSING	12 SICKENING	
THROBBING	SUFFOCATING	
BEATING	13 FEARFUL	
POUNDING	FRIGHTFUL	
2 JUMPING	TERRIFYING	
FLASHING	14 PUNISHING	
SHOOTING	GRUELLING	
3 PRICKING	CRUEL	
BORING	VICIOUS	
DRILLING	KILLING	
STABBING	15 WRETCHED	
LANCINATING	BLINDING	
4 SHARP	16 ANNOYING	
CUTTING	TROUBLESOME	
LACERATING	MISERABLE	
5 PINCHING	INTENSE	
PRESSING	UNBEARABLE	
GNAWING	17 SPREADING	
CRAMPING	RADIATING	
CRUSHING	PENETRATING	
6 TUGGING	PIERCING	
PULLING	18 TIGHT	
WRENCHING	NUMB	
7 HOT	DRAWING	
BURNING	SQUEEZING	
SCALDING	TEARING	
SEARING	19 COOL	
8 TINGLING	COLD	
ITCHY	FREEZING	
SMARTING	20 NAGGING	
STINGING	NAUSEATING	
9 DULL	AGONIZING	
SORE	DREADFUL	
HURTING	TORTURING	
ACHING	PPI	
HEAVY	0 No pain	
10 TENDER	1 MILD	
TAUT	2 DISCOMFORTING	
RASPING	3 DISTRESSING	
SPLITTING	4 HORRIBLE	
	5 EXCRUCIATING	

PPI_____ COMMENTS:



CONSTANT
PERIODIC
BRIEF

ACCOMPANYING SYMPTOMS:	SLEEP:	FOOD INTAKE:
NAUSEA	GOOD	GOOD
HEADACHE	FITFUL	SOME
DIZZINESS	CAN'T SLEEP	LITTLE
DROWSINESS	COMMENTS:	NONE
CONSTIPATION		COMMENTS:
DIARRHEA	ACTIVITY:	COMMENTS:
COMMENTS:	GOOD	
	SOME	
	LITTLE	
	NONE	

Figure. The McGill-Melzack Pain Questionnaire.[10] *The classes of words are sensory, 1 to 10; affective, 11 to 15; evaluative, 16; and miscellaneous, 17 to 20. The rank value for each word is based on the position in the word set. The sum of the rank values is the pain rating index (PRI). The index of the present pain intensity (PPI) is based on a scale of 0 to 5.*

been informed about the study. The physical therapist opened the sealed allocation envelope and administered the prescribed therapy.

After each treatment session, the patients returned to the research associate for reevaluation with the MPQ and ROM tests. The patient was draped with a hospital gown so that the research associate could not observe any physical signs, such as marks left by the suction cups, that might provide clues regarding the form of therapy. As indicated above, the ROM tests were chosen because they did not require examination of the stimulated area. Further, the patients were instructed not to discuss any aspect of treatment with the research associate during the evaluation.

When the patients returned for the next treatment, the research coordinator opened the files and referred the patient to the research associate for the MPQ and ROM tests and to the same physical therapist for treatment. This procedure was continued until each patient received 10 treatments or until a patient or therapist decided to terminate treatment on the basis of the criteria described above.

This procedure was effective in maintaining the "double-blind" throughout the study because 1) the

TABLE 1

Mean Percentage Decreases in Pain Rating Index (PRI) and Present Pain Intensity (PPI) and Mean Percentage Changes in Back Flexion and Straight Leg Raising (SLR) for Left and Right Legs After Treatment with TENS or Massage

Treatment Group	n	% Decrease PRI	% Decrease PPI	% Change Flexion[a]	% Change SLR(L)[b]	% Change SLR(R)[b]
TENS	20	69.5 (7.5)[c]	80.8 (10.1)	−2.5 (4.5)	−9.6 (3.8)	−16.1 (8.3)
Massage	21	37.2 (6.4)	40.9 (6.9)	−4.7 (2.9)	+3.4 (4.4)	+1.7 (4.2)
p		.001	.001	NS	.02	.03

[a] + = better; − = worse.
[b] + = worse; − = better.
[c] Standard error (in parentheses).

research associate who recorded the data did not know which modality was used for the individual patients during the treatment sessions; 2) the patients expected that both methods were potentially equally effective; and 3) the physical therapists believed that each procedure would provide relief and did not communicate with the research associate regarding the treatment modality during the study.

RESULTS

The mean percentage changes in pain scores and range-of-motion measures are shown in Table 1. Individual *t* tests showed that TENS produced significantly larger changes than massage in PRI, PPI, SLR (left) and SLR (right). These effects cannot be attributed to any variables other than treatment. There were no statistically significant differences between the two groups on any of the pain or ROM measures before treatment. Moreover, there were no differences between the two groups in age, sex, duration of the pain, or average number of treatment sessions (TENS, 5.1 sessions; massage, 5.6 sessions).

Significant correlation coefficients between pain scores and range-of-motion measures are shown in Table 2. The negative correlations between pain scores and SLR indicate that large pain decreases are associated with large negative scores, which represent an improvement—that is, the leg could be raised higher than before treatment.

TABLE 2

Significant Correlation Coefficients Between Changes in Pain Scores and Changes in Flexion and Straight Leg Raising of the Left and Right Legs

Treatment Group	Variables[a]	*r*	*p*
TENS	PPI—SLR(L)	−.83	.001
	PRI—Flexion	+.61	.002
Massage	PPI—SLR(L)	−.36	.05
	PPI—SLR(R)	−.44	.02

[a] PPI = present pain intensity; PRI = pain rating index; SLR = straight leg raising.

Permitting termination of treatment by patients who believed they were not being helped (or whose condition was judged by the therapist to be worse) provided an additional indication of the relative effectiveness of each treatment. In the massage group, 7 patients considered their condition to be improved, whereas 11 were terminated because they believed they were not being helped. In the TENS groups, 10 were judged improved, 4 not improved. A judgment was not possible for the remaining patients. These data are remarkably similar to the statistical results and provide further evidence of their validity and consistency.

A final measure of relative effectiveness was obtained by determining the percentages of patients in each group who obtained mean pain relief scores greater than 50 percent based on the PRI. The results were as follows: massage—38 percent (8/21); TENS—85 percent (17/20). These scores reflect the relative effectiveness rating obtained with all other measures.

DISCUSSION

The results show that TENS is significantly more effective for relieving pain and increasing straight leg raising than massage. The lack of significant improvement in back flexion, however, is indicative of the complexity of the back pain syndrome. It is not surprising that activity in a particular set of muscles is improved while that in another set is not. Nevertheless, the highly significant correlation between flexion and the PRI—the more sensitive of the two pain measures[10]—suggests that flexion may be a complex measure that is related to pain but as an index of physical improvement is affected by factors that are not understood.

The correlations between pain and physical measures are particularly interesting. Pain is rarely measured by physical therapists as an index of improvement of a patient's physical condition or of the effectiveness of a given modality. The relatively high

significant correlations between the standard physical measures of straight leg raising and back flexion and a simple subjective measure like the PPI suggest that pain should be routinely assessed when therapy is provided for pain as well as for improvement in physical condition. The PRI may be the more desirable measure in research studies that require sensitive indexes of pain or that are especially concerned with the relative affective or sensory contributions to pain. However, when the primary concern is *change* in overall pain caused by a therapeutic intervention, the PPI provides valid, reliable information. In an earlier study of TENS, the following correlation coefficients between PPI percentage changes and the percentage changes for each of the PRI indexes were found: sensory, .90; affective, .82; evaluative, .96; miscellaneous, .92; total, .94.[10] The magnitude of these correlations shows clearly that the PPI can be highly useful in determining changes in pain as a result of physical therapy. Further, the PPI can be obtained simply and quickly. The results of the present study suggest that it should become a standard measure in physical therapy departments.

The gentle massage used in this study could conceivably be viewed as a placebo control procedure for evaluating the effectiveness of TENS. The efficiency of the placebo on all pain measures is about 50 percent of that of TENS, which is comparable to the placebo efficiency found in most experiments involving a double-blind comparison of a pharmacological analgesic and a placebo.[15] And, indeed, the design of the present study meets the requirements of a double-blind experiment. Our results, then, demonstrate that TENS, as we applied it, is significantly more effective for relieving back pain and increasing SLR than the placebo control procedure of gentle massage as applied at the painful area by means of a mechanical device.

Although the effectiveness of TENS has been demonstrated, the mechanisms responsible for its effectiveness remain to be fully elucidated. There is evidence that intense somatic stimulation is able to inhibit the transmission of pain signals directly at the level of the spinal cord.[16] In addition, intense somatic input projects to the central gray matter in the midbrain which in turn activates a powerful descending inhibitory control system.[17] Both of these inhibitory influences—spinal and supraspinal—would "close the gate"[18] to ascending pain signals and diminish or block pain significantly.

This study was concerned with assessing the relative effectiveness of TENS and not with duration of relief or the continued effectiveness of TENS. There is convincing evidence, however, that the duration of pain relief may long outlast the brief duration of stimulation and that relief may continue for a period of years for a substantial number of patients.[2, 3, 8, 9]

CONCLUSIONS

The results show clearly that TENS is an effective modality for the treatment of low back pain. Because of the double-blind, randomized design of the study, the significant effectiveness of TENS cannot be attributed to other factors such as placebo efficiency or other psychological effects. The significant correlations between pain-relief scores and range-of-motion scores highlight the usefulness of pain evaluation. The PPI score of the MPQ can be obtained in less than a minute and provides valuable information about subjective pain relief that can complement range-of-motion scores.

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